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Solar Based Smart Cropping Defence System Using IoT Based On Birds And Animals

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Abstract:
Preserving their harvest from wild animals and unauthorized intrusions is a significant difficulty for farmers. The Farm Guardian, a solar-powered, IoT-enabled automated crop protection system, helps solve this. This technology uses an microprocessor alongside touch sensors and ultrasonic sensors to detect movement and touch. Should dangers be discovered, the HCSR04 ultrasonic sensor's continuous object distance monitoring sets off a buzzer and warning system. A solar-powered electric fence keeps animals or trespassers off the perimeter, hence enhancing security by means of a slight deterrent shock. the system sends alerts and actual data to an Android phone belonging to a farmer, therefore enabling remote monitoring effective operation with a 12V solar photovoltaic power source changed to 5V DC for the control unit and sensors. Output modules for buzzers, LED indicators, a servo motor, and a user interface oLED screen constitute the system. Automated, affordable, environmentally friendly means of crop protection using renewable energy is provided by Farm Guardian. The suggested strategy maintains ecologically sustainable farming methods, secures the farm efficiently, decreases dependence on traditional fences, and lowers human interference.

Keywords*— Internet of Things (IoT), Smart Agriculture, Crop Protection, Solar-Powered System, Ultrasonic Sensor, Electric Fence, Intrusion Detection, Renewable Energy, Remote Monitoring, Embedded Systems.*

Introduction

Agriculture remains one of the most important sectors contributing to food security, rural employment, and economic development across the world. However, agricultural production is continuously threatened by crop damage caused by wild animals, birds, and unauthorized human intrusion. In many rural regions, farmers suffer significant economic losses due to the destruction of standing crops by animals such as wild boars, monkeys, deer, elephants, and stray cattle. Conventional crop protection methods, including manual surveillance, scarecrows, barbed fencing, and chemical repellents, have limited effectiveness because they require continuous human supervision, incur recurring costs, and often fail to provide protection during nighttime or adverse weather conditions. Consequently, there is an increasing demand for intelligent and automated crop protection systems capable of providing continuous monitoring while minimizing human intervention. Recent advances in embedded systems, wireless communication, and renewable energy technologies have created new opportunities for developing sustainable smart farming solutions that enhance agricultural productivity while reducing operational costs. **[1], [2]**

The rapid development of the Internet of Things (IoT) has transformed traditional agricultural practices into intelligent farming systems capable of monitoring environmental conditions and automating field operations in real time. IoT integrates sensors, embedded controllers, wireless communication modules, and cloud-based platforms to collect, process, and transmit field information without continuous human involvement. In modern agriculture, IoT applications include precision irrigation, greenhouse automation, soil monitoring, livestock management, pest detection, and crop protection. Continuous monitoring through interconnected sensing devices enables farmers to receive instant notifications regarding abnormal conditions, thereby improving decision-making and reducing crop losses. The adoption of IoT technologies has significantly enhanced agricultural efficiency by enabling data-driven management practices that optimize resource utilization while maintaining environmental sustainability. **[6], [13], [14]**

Among the various technologies used for intelligent crop protection, ultrasonic sensing has gained considerable attention because of its ability to detect approaching objects without physical contact. Ultrasonic sensors continuously emit high-frequency sound waves and determine the distance of nearby objects by measuring the reflected signals. This sensing mechanism allows the detection of birds, animals, and human movement near agricultural fields with high reliability. Compared with traditional motion detection techniques, ultrasonic sensors are inexpensive, energy efficient, and suitable for outdoor agricultural environments. Their compatibility with embedded microcontrollers enables continuous surveillance and rapid response to intrusion events, making them an effective component of automated crop protection systems. **[3], [5], [7]**

Solar energy has emerged as one of the most promising renewable energy sources for agricultural automation because it provides uninterrupted electrical power in remote farming locations where conventional grid connectivity may not be available. Solar photovoltaic panels convert sunlight into electrical energy that can be utilized to operate sensors, communication modules, embedded controllers, and security systems throughout the day. The integration of rechargeable batteries further enables continuous system operation during nighttime and cloudy weather conditions. Solar-powered agricultural systems reduce dependence on fossil fuels, minimize operating costs, and support environmentally sustainable farming practices. Consequently, renewable energy has become an integral component of modern smart agriculture, particularly for autonomous field monitoring and crop protection applications. **[2], [6], [8]**

Wireless communication technologies further improve the effectiveness of intelligent crop protection systems by enabling remote monitoring through mobile devices. Embedded communication modules transmit real-time notifications whenever intrusion events or abnormal activities are detected within agricultural fields. Farmers can remotely monitor system status, receive warning messages, and initiate appropriate actions without being physically present at the farm. The integration of wireless communication with cloud-based monitoring platforms also facilitates historical data storage, performance analysis, and maintenance planning. Such capabilities improve farm management efficiency while ensuring rapid response to potential threats. **[11], [13], [15]**

In addition to intrusion detection, automated deterrent mechanisms play an essential role in minimizing crop damage. Audible alarms, LED warning indicators, servo-controlled mechanical devices, and low-voltage electric fencing provide immediate responses that discourage animals and unauthorized persons from entering protected areas. Unlike conventional fencing systems, smart electric fences operate only when intrusion is detected, thereby reducing energy consumption while maintaining high levels of protection. Combining multiple deterrent techniques within a single intelligent framework enhances system reliability and improves crop security under varying environmental conditions. These integrated approaches support sustainable agricultural practices by reducing dependence on harmful chemical repellents and minimizing unnecessary human intervention. **[4], [7], [9]**

The proposed **Solar Based Smart Cropping Defence System Using IoT Based on Birds and Animals** has been developed to address these challenges through the integration of ultrasonic sensors, touch sensors, a microcontroller, GSM-based communication, OLED display, servo motor, buzzer, LED indicators, and a solar-powered electric fencing system. The ultrasonic sensor continuously monitors object movement near the farm boundary, while touch sensors detect physical contact with the protective fence. Whenever an intrusion is identified, the system activates audible and visual warning mechanisms, transmits alert messages to the farmer's Android device, and stores operational information for continuous monitoring. The entire system is powered using solar photovoltaic energy, ensuring uninterrupted operation while reducing electricity consumption and supporting environmentally sustainable agriculture. The proposed architecture provides an economical, intelligent, and reliable crop protection solution capable of improving farm security, reducing crop losses, and promoting precision agriculture through renewable energy and Internet of Things technologies. **[1], [6], [10], [14]**

Literature Survey

M. Jaya Prabha et al. developed an IoT-based smart crop protection system designed to reduce crop losses caused by wild animals entering agricultural fields. Their proposed framework employed embedded controllers and sensing devices to monitor farm boundaries continuously and generate warning signals whenever animal movement was detected. The study demonstrated that integrating wireless communication with embedded hardware significantly reduced the dependency on manual surveillance while improving the reliability of crop monitoring. The researchers emphasized that automated detection systems can protect crops during both daytime and nighttime operations, thereby increasing agricultural productivity. However, the proposed system primarily focused on intrusion detection and did not consider renewable energy integration or intelligent power management, limiting its applicability in remote farming locations where grid electricity is unavailable. **[1]**

Sonal D. Khandare et al. presented a comprehensive review of solar-powered fencing systems integrated with GSM communication for agricultural applications. The authors discussed the

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advantages of utilizing photovoltaic energy as a sustainable power source for electric fencing systems, particularly in rural areas where uninterrupted electrical supply is often unavailable. Their work highlighted that GSM technology enables farmers to receive instant notifications regarding fence activation and intrusion events, thereby reducing crop damage and improving farm security. The review further explained that solar-powered fencing minimizes operational costs while supporting environmentally sustainable farming practices. Nevertheless, the proposed approach mainly relied on fencing mechanisms and lacked intelligent sensing modules capable of distinguishing between different intrusion sources such as birds, animals, and human trespassers. **[2]**

V. Atchaya et al. proposed an embedded crop protection system specifically developed to prevent crop damage caused by wild animal attacks. The system utilized motion detection sensors and a microcontroller to identify approaching animals and activate audible warning devices for deterrence. Experimental observations indicated that automatic detection considerably reduced response time compared with conventional manual monitoring methods. The authors also reported that embedded automation improved system reliability while minimizing the continuous involvement of farmers. However, the developed system did not incorporate Internet of Things technology, remote monitoring capabilities, or cloud-based data management, restricting farmers from observing field conditions when they were away from the agricultural site. **[3]**

Omkar Kekre et al. introduced an ethical crop protection framework based on IoT technology that emphasized non-lethal methods for protecting agricultural fields from animal intrusion. Instead of causing physical harm to animals, the proposed system employed electronic warning mechanisms and intelligent monitoring techniques to discourage animals from entering cultivated areas. The authors demonstrated that combining sensors with automated control devices provided an effective and environmentally responsible alternative to traditional trapping or chemical deterrents. Their work promoted sustainable agriculture by maintaining ecological balance while reducing crop losses. Despite these advantages, the study provided limited discussion regarding renewable energy utilization and long-term autonomous operation under varying environmental conditions. **[4]**

N. Srikanth et al. designed a smart crop protection system capable of simultaneously detecting wild animals and fire hazards using an Arduino-based embedded platform. The proposed architecture integrated multiple sensors for monitoring different environmental conditions and activated warning mechanisms whenever abnormal events were detected. The study demonstrated that multi-hazard monitoring significantly enhanced agricultural safety by protecting crops from both biological threats and accidental fire incidents. The integration of multiple sensing technologies also reduced hardware complexity while improving operational efficiency. However, the communication capabilities of the system were relatively limited, and the absence of cloud-based monitoring restricted long-term data analysis and predictive maintenance capabilities. **[5]**

F. Rahman et al. presented a comprehensive solar-powered smart agriculture system integrating intelligent irrigation, weather monitoring, and crop disease detection within a unified IoT framework. Their research demonstrated that renewable energy combined with Internet of Things technologies enables continuous agricultural monitoring while minimizing dependence on conventional electrical infrastructure. The cloud-enabled architecture facilitated real-time data collection, environmental monitoring, and remote accessibility through mobile applications. The authors concluded that solar-powered IoT systems significantly improve agricultural productivity, optimize energy utilization, and reduce maintenance costs. Although the proposed framework focused primarily on irrigation and environmental monitoring, its architecture provides valuable guidance for integrating renewable energy with intelligent crop protection systems capable of detecting birds, animals, and unauthorized intrusions. **[6]**

A. S. Bhosale and A. Patil designed a solar-powered pest control system that employed ultrasonic sound waves to repel birds and small animals from agricultural fields without causing physical harm. Their study emphasized the use of renewable energy to operate the ultrasonic transmitter continuously, making the system suitable for remote farming locations where electricity availability is limited. Experimental observations indicated that ultrasonic frequencies effectively discouraged several crop-damaging species while maintaining low power consumption throughout operation. The researchers also highlighted that integrating solar energy significantly reduced operating costs and improved system sustainability. However, the proposed system primarily focused on pest repulsion and did not incorporate intelligent sensing, remote monitoring, or communication modules capable of notifying farmers about intrusion events. These limitations suggest the need for a comprehensive IoT-enabled monitoring framework that combines detection, communication, and automated deterrent mechanisms. **[7]**

A. V. Satpute and S. V. Kadam investigated the application of solar energy in smart agriculture by integrating photovoltaic power with embedded agricultural automation systems. Their research demonstrated that solar-powered monitoring units could operate continuously under varying environmental conditions while minimizing dependence on conventional electrical infrastructure. The authors reported that renewable energy improves system reliability, reduces maintenance costs, and supports environmentally sustainable agricultural practices. Furthermore, the study emphasized that autonomous solar-powered devices are particularly beneficial for rural farming areas where uninterrupted power supply cannot be guaranteed. Although their work focused mainly on agricultural automation and irrigation, the proposed renewable energy framework provides an effective foundation for implementing intelligent crop protection systems that require continuous operation throughout the growing season. **[8]**

A. K. Yadav and A. Kumar developed a solar-powered agricultural pest control system that combined embedded electronics with renewable energy to protect crops from insect and animal attacks. Their system utilized electronic deterrent mechanisms activated through sensor-based monitoring while being powered entirely by photovoltaic panels. The authors concluded that renewable energy significantly improved system autonomy and reduced operational expenses compared with conventional electrically powered protection systems. The study further demonstrated that automated pest control minimizes the use of chemical repellents, thereby supporting environmentally friendly farming practices. Nevertheless, the proposed architecture lacked Internet of Things connectivity and mobile communication features that would allow farmers to monitor crop security remotely and receive immediate intrusion alerts. **[9]**

D. K. Fisher and H. A. Kebede proposed a low-cost microcontroller-based agricultural monitoring system capable of continuously measuring crop temperature and water status. Their research demonstrated that embedded sensor networks improve agricultural decision-making by providing real-time environmental information for precision farming applications. The authors highlighted the advantages of low-cost microcontrollers in reducing implementation expenses while maintaining satisfactory monitoring accuracy. Their study also showed that continuous environmental monitoring contributes to efficient resource utilization and enhances crop productivity. Although the research primarily addressed irrigation management rather than crop protection, the embedded sensing architecture and data acquisition techniques provide valuable guidance for developing intelligent monitoring systems capable of integrating intrusion detection and environmental sensing within a unified agricultural platform. **[10]**

K. Kashika, A. Akhil, and K. Reddy investigated cloud scheduling algorithms for efficient resource management in distributed computing environments. The authors explained that cloud computing enables reliable storage, rapid information processing, and efficient allocation of computational resources for Internet of Things applications. Their work demonstrated that optimized cloud scheduling improves system performance, minimizes processing delays, and enhances data accessibility for remote users. In agricultural applications, cloud platforms facilitate centralized monitoring of sensor data while enabling farmers to access field information through mobile devices from any location. Although the study focused primarily on cloud resource management, its findings support the implementation of cloud-enabled smart agriculture systems where intrusion events, environmental conditions, and historical farm data can be securely stored and analyzed for future decision-making. **[11]**

M. C. Rodríguez-Sánchez, S. Borromeo, and J. A. Hernández-Tamames presented a comprehensive study on wireless sensor networks designed for environmental monitoring and distributed sensing applications. The researchers demonstrated that wireless sensor networks provide reliable real-time data acquisition while minimizing wiring complexity and maintenance requirements. Their work emphasized the scalability, flexibility, and energy efficiency of wireless sensing technologies for monitoring large geographical regions. The study further concluded that integrating wireless communication with distributed sensors significantly improves remote monitoring capabilities and supports intelligent decision-making through continuous environmental observation. Although the research was conducted for environmental monitoring applications, the proposed wireless sensor network architecture can be effectively adapted for agricultural intrusion detection, crop monitoring, and smart farm automation systems that require continuous data collection from multiple sensing locations. **[12]**

Research Gap

The existing literature demonstrates considerable progress in developing automated crop protection systems using embedded controllers, solar energy, wireless communication, and Internet of Things technologies. Several studies have focused on intrusion detection using motion sensors, ultrasonic sensors, or electric fencing, while others have emphasized renewable energy utilization, precision agriculture, cloud computing, and environmental monitoring. However, most existing systems

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address only individual aspects of crop protection, such as animal detection, pest control, irrigation automation, or weather monitoring, without integrating all essential functions into a unified intelligent framework. Furthermore, many reported systems lack real-time mobile notifications, simultaneous bird and animal detection, touch-based intrusion sensing, solar-powered autonomous operation, and intelligent communication capabilities for remote monitoring.

The proposed **Solar Based Smart Cropping Defence System Using IoT Based on Birds and Animals** addresses these limitations by integrating ultrasonic sensing, touch sensing, solar-powered electric fencing, GSM communication, embedded processing, OLED-based local monitoring, and Android-based remote notification within a single platform. The proposed architecture provides continuous surveillance, rapid intrusion detection, renewable energy utilization, and automated warning mechanisms while minimizing human intervention and operational costs. This integrated approach offers a comprehensive solution for sustainable crop protection in modern precision agriculture.

Proposed System:

The proposed system is a solar-based smart crop defence system using IoT, which provides an automated and efficient solution. It uses solar panels to generate electricity, making it eco-friendly and suitable for remote areas. Sensors like PIR and ultrasonic sensors detect the movement of birds and animals. When an intrusion is detected, the system activates deterrents such as alarms or lights and sends instant alerts to the farmer through mobile applications. This system works continuously without human intervention, ensuring 24/7 monitoring. It reduces labor, increases efficiency, and offers a reliable, cost-effective solution for modern agriculture.

Block Diagram

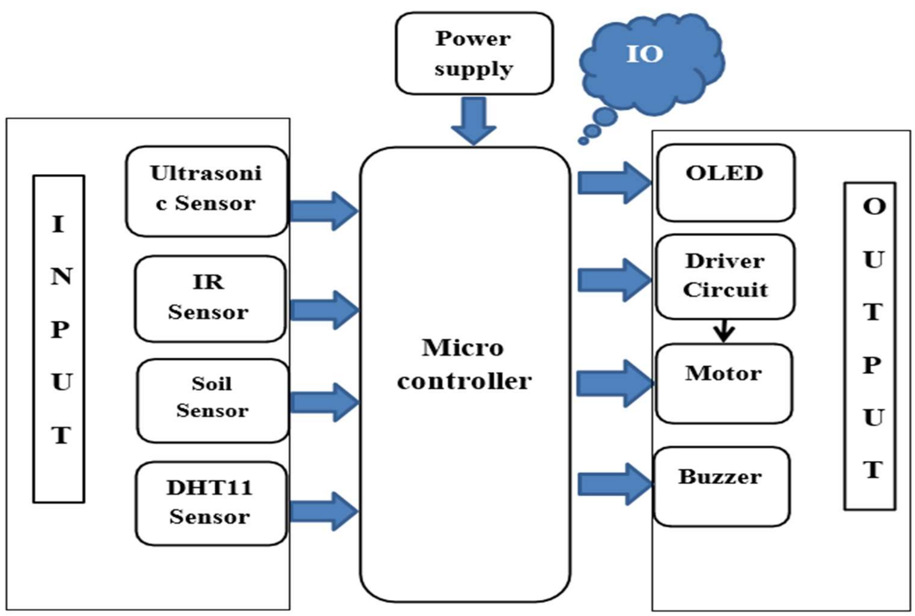

Figure 1: Proposed Blockdiagram

Proposed System

Block Diagram Description

Figure 1 illustrates the architecture of the proposed Solar Based Smart Cropping Defence System Using IoT Based on Birds and Animals. The system integrates sensing devices, a microcontroller-based processing unit, renewable energy, and output modules to provide continuous crop protection against birds, wild animals, and unauthorized intrusions. The architecture is organized into four functional sections: the power supply unit, input sensing unit, processing unit, and output unit.

The entire system is powered through a solar-powered energy source, making it suitable for deployment in agricultural fields where uninterrupted grid electricity is unavailable. The photovoltaic panel converts solar energy into electrical energy, which is regulated through the power supply circuit to provide a stable operating

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voltage for the microcontroller, sensors, and peripheral devices. The renewable energy source enables continuous field operation while reducing electricity costs and supporting environmentally sustainable farming practices.

The input section consists of four sensing devices that continuously monitor the agricultural field under different environmental conditions. The ultrasonic sensor measures the distance between the monitoring unit and approaching objects by transmitting high-frequency sound waves and receiving their reflected echoes. When birds, animals, or unauthorized persons enter the protected area, the measured distance decreases below a predefined threshold, indicating an intrusion event.

The IR sensor complements the ultrasonic sensor by detecting the movement or presence of nearby objects through infrared radiation. This additional sensing mechanism improves the reliability of intrusion detection, particularly when small birds or fast-moving animals approach the crop field. Using two independent sensing techniques minimizes false alarms caused by environmental disturbances.

The soil moisture sensor continuously measures the moisture content of the soil surrounding the crops. The collected information allows the system to provide real-time feedback regarding soil conditions and helps farmers understand whether irrigation may be required. Although the primary objective of the proposed system is crop protection, incorporating soil monitoring increases the overall usefulness of the agricultural monitoring platform.

The DHT11 sensor measures the ambient temperature and relative humidity of the agricultural environment. These environmental parameters are useful for monitoring climatic conditions that influence crop growth and can also assist farmers in planning irrigation and field management activities. The environmental information is displayed locally and can be transmitted through IoT-based communication for remote observation.

At the center of the system is the microcontroller, which serves as the primary processing unit. It continuously receives data from all connected sensors, processes the acquired information using predefined decision logic, and determines the appropriate response according to the detected conditions. The microcontroller coordinates communication among all hardware modules and ensures synchronized operation throughout the monitoring process.

The architecture also incorporates an IoT communication interface, allowing field information to be transmitted to a remote monitoring platform. Sensor readings, intrusion status, and environmental conditions can be accessed remotely by the farmer using a mobile application or web-based dashboard. This feature enables continuous farm monitoring even when the farmer is away from the agricultural field.

The output section consists of four major modules. The OLED display provides local visualization of system information, including sensor readings, intrusion status, soil moisture level, temperature, and humidity. This enables on-site monitoring without requiring additional equipment.

The driver circuit acts as an interface between the low-power microcontroller and the higher-power actuator. Since the microcontroller cannot directly drive the motor due to current limitations, the driver circuit amplifies the control signal and safely operates the motor according to the instructions received from the controller.

The motor performs the mechanical protection action whenever an intrusion is detected. Depending on the installation, the motor may rotate a scare device, activate a mechanical barrier, or control another deterrent mechanism designed to discourage birds and animals from entering the cultivated area.

Finally, the buzzer functions as an audible warning device. Whenever an intrusion is confirmed by the sensing unit, the buzzer immediately generates a high-intensity alarm to frighten away birds and animals while simultaneously alerting nearby farm personnel. The coordinated operation of all these modules enables continuous crop monitoring, rapid intrusion detection, and automatic protective action with minimal human intervention.

Workflow of the Proposed System

The operation of the proposed smart crop protection system follows a structured sequence of sensing, processing, decision-making, communication, and protective action.

Step 1: Solar Energy Generation

The photovoltaic panel converts sunlight into electrical energy. The regulated power supply distributes stable DC voltage to the microcontroller, sensors, communication modules, and output devices, enabling uninterrupted operation throughout the day.

Step 2: Continuous Environmental Monitoring

The ultrasonic sensor continuously measures the distance of nearby moving objects, while the IR sensor detects motion around the protected farming area. Simultaneously, the soil moisture sensor measures soil water content, and the DHT11 sensor records ambient temperature and humidity.

Step 3: Data Collection

The outputs generated by all sensors are transmitted to the microcontroller. The controller continuously samples the sensor readings at predefined intervals and stores them temporarily for processing.

Step 4: Data Processing

The microcontroller compares the acquired sensor values with predefined threshold levels. If all measured values remain within normal operating

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conditions, the monitoring cycle continues without activating any output device.

Step 5: Intrusion Detection

Whenever the ultrasonic sensor detects an approaching object or the IR sensor identifies movement near the protected area, the controller classifies the event as a potential intrusion. The controller verifies the sensor readings before initiating protective actions to reduce false alarms.

Step 6: Protective Response

Once the intrusion is confirmed, the controller activates the driver circuit, which powers the motor to operate the installed deterrent mechanism. Simultaneously, the buzzer produces an audible warning to scare away birds or animals and notify nearby personnel.

Step 7: Local Information Display

The OLED display continuously presents the latest sensor readings, environmental conditions, and system status, allowing farmers to monitor the operation of the protection system directly at the installation site.

Step 8: IoT-Based Remote Monitoring

The processed information is transmitted through the IoT communication module to the farmer's mobile device or cloud platform. Remote users can monitor intrusion events, environmental parameters, and system status in real time.

Step 9: Continuous Operation

After completing the protective action, the controller automatically returns to monitoring mode and repeats the sensing cycle continuously. This autonomous operation provides uninterrupted crop protection with minimal manual supervision.

Implementation of the Proposed System

The implementation of the proposed system begins with the installation of a solar photovoltaic panel capable of supplying sufficient electrical power for continuous field operation. The generated electrical energy is regulated through a power conditioning circuit before being distributed to the microcontroller, sensors, communication interface, and output devices. A rechargeable battery may be incorporated to ensure uninterrupted operation during nighttime and periods of low solar radiation.

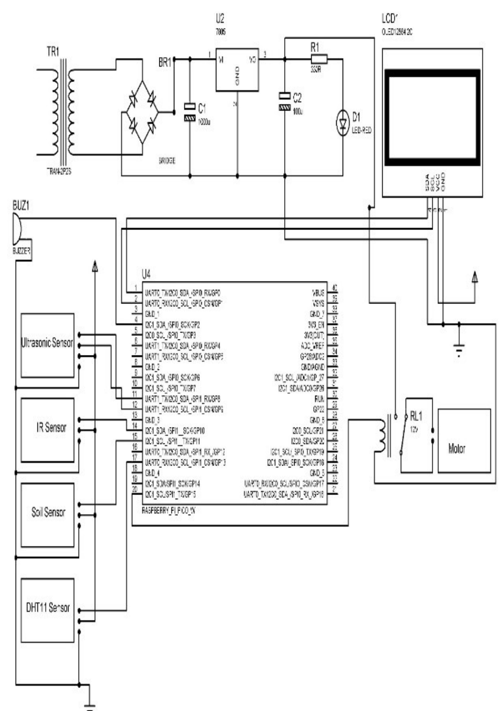
The sensing unit is deployed at strategic locations around the agricultural field to maximize coverage. The ultrasonic sensor is mounted at an appropriate height to monitor approaching birds, animals, and unauthorized individuals, while the IR sensor is positioned to improve movement detection near the protected area. The soil moisture sensor is inserted into the cultivated soil to measure moisture content accurately, whereas the DHT11 sensor is installed in an open but sheltered position to record ambient temperature and humidity.

The microcontroller is programmed using embedded software that continuously acquires sensor readings, filters noise, compares the measured values with predefined threshold limits, and determines the required system response. When intrusion is detected, the controller simultaneously activates the driver circuit, motor, and buzzer while updating the OLED display with the latest system status. Environmental information collected from the soil moisture and DHT11 sensors is also displayed for local observation.

The IoT communication module periodically transmits sensor readings and system status to a remote monitoring platform, enabling farmers to observe field conditions using a smartphone or other internet-connected device. This communication capability improves farm management by allowing immediate response to intrusion events even when the farmer is away from the agricultural field.

The complete implementation integrates renewable energy, embedded sensing, intelligent control, and wireless communication into a single autonomous crop protection platform. The proposed system reduces dependence on manual surveillance, decreases operating costs through solar energy utilization, and provides reliable protection against birds, wild animals, and unauthorized intrusions while simultaneously supporting environmental monitoring for improved agricultural management.

Schematic Diagram:



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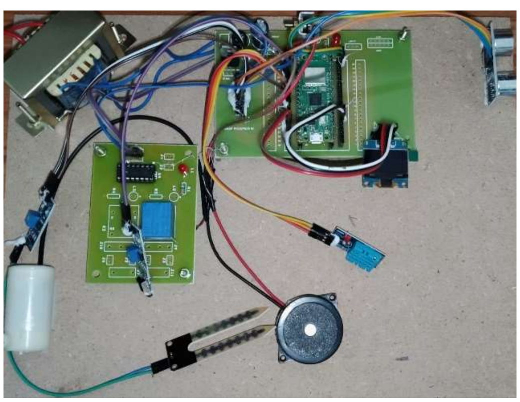
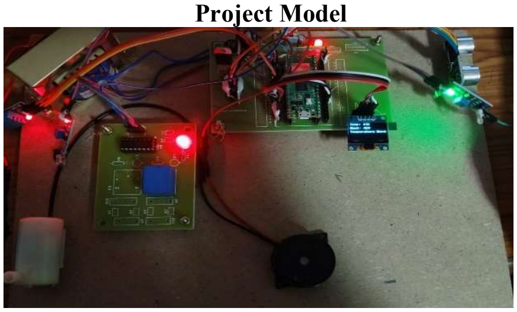
RESULTS:

The developed Solar Based Smart Cropping Defence System Using IoT Based on Birds and Animals was implemented as a hardware prototype to validate the functionality of the proposed architecture. The prototype successfully integrated the ultrasonic sensor, IR sensor, soil moisture sensor, DHT11 temperature and humidity sensor, microcontroller, OLED display, driver circuit, motor, buzzer, and IoT communication module into a single monitoring platform.

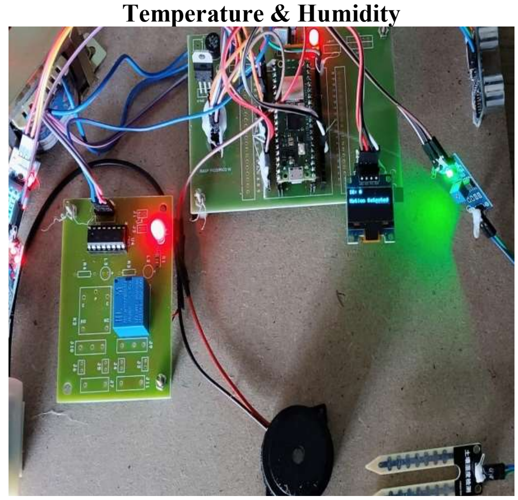
The experimental observations confirm that each sensing module operated according to its intended functionality. The ultrasonic sensor detected approaching objects within the predefined sensing range, while the IR sensor accurately identified motion around the protected area. The soil moisture sensor continuously monitored soil conditions, and the DHT11 sensor provided real-time environmental information including temperature and humidity. Whenever an intrusion was detected, the microcontroller activated the buzzer and motor through the driver circuit while simultaneously updating the OLED display with the current system status. The IoT communication interface enabled remote monitoring by transmitting sensor information to the connected platform. The hardware prototype demonstrated stable operation under laboratory conditions, indicating that the proposed system can effectively provide automated crop monitoring and protection with minimum human intervention.



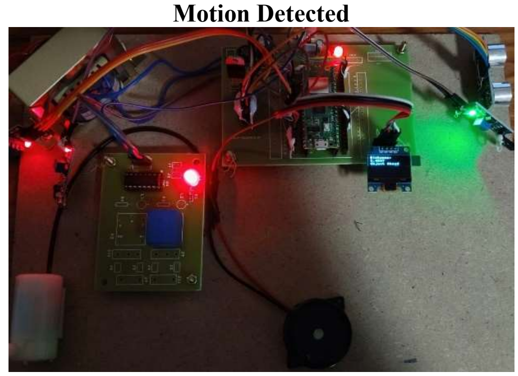
Project Model



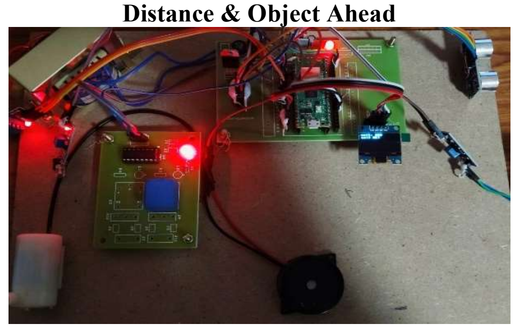
Temperature & Humidity



Motion Detected



Distance & Object Ahead



Soil Conditions

Conclusion

This work presented the design and implementation of a **Solar Based Smart Cropping Defence System Using IoT Based on Birds and Animals** for improving agricultural security through intelligent monitoring and renewable energy utilization. The proposed system integrates ultrasonic sensing, infrared motion detection, soil moisture monitoring, temperature and humidity measurement, embedded processing, IoT communication, OLED display, motor control, and audible warning mechanisms within a single autonomous platform powered by solar energy.

The developed hardware prototype successfully demonstrated continuous environmental monitoring, intrusion detection, automated warning generation, and remote observation through IoT communication. The experimental evaluation confirmed that the integrated sensing modules operated reliably and that the controller effectively coordinated all system components to provide timely protective actions whenever intrusion events were detected. The use of solar energy enables uninterrupted operation in remote agricultural areas while reducing dependence on conventional electrical infrastructure. Overall, the proposed system provides a cost-effective, environmentally sustainable, and intelligent solution for protecting crops from birds, animals, and unauthorized intrusions while simultaneously supporting precision agriculture through environmental monitoring.

Future Scope

The proposed system can be further enhanced by incorporating advanced technologies to improve its intelligence, scalability, and practical deployment in large agricultural fields.

- Artificial Intelligence and Machine Learning algorithms can be integrated to distinguish between birds, domestic animals, wild animals, and human intruders, thereby reducing false alarms.
- A camera module with computer vision can be added to capture images of intrusion events and provide visual confirmation to farmers through a mobile application.
- GPS technology may be incorporated to identify the exact location of intrusion within large agricultural farms.
- LoRaWAN or NB-IoT communication technologies can replace conventional wireless communication to achieve long-range monitoring with lower power consumption.
- Cloud computing and big data analytics can be employed to maintain long-term agricultural records and generate predictive recommendations for crop protection and farm management.
- Solar battery management systems can be optimized to improve energy efficiency during prolonged cloudy weather conditions.
- Integration with automatic irrigation and fertilizer control systems can transform the proposed prototype into a complete smart farming platform capable of supporting precision agriculture.

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